5857

PROPOSED SURFACE DRAINAGE SCHEME

FOR

THE CITY OF BHARATPORE,

RAJPOOTANA.

At the request of the Council in charge of the Native State of Bharatpore, I visited Bharatpore to prepare a report on a drainage scheme for the City and its Suburbs. I inspected the City and its neighbourhood on the 9th, 10th and 11th September 1905, with Mr. Burke, Offig: State Engineer, various Municipal Commissioners and the Indian Assistant Engineer. On the night of the 9th September one inch of rain fell, which assisted me in forming an opinion on the drainage question; I again visited Bharatpore from the 9th to 13th October 1905, and completed my enquiries with the assistance of levels and information obtained for me by the Assistant Engineer.

The Political Agent, Mr. Clogstoun, and the State Engineer, Mr. Judd were exceedingly kind in assisting me in my enquiries.

A brief description of the City and its history will be of interest, and enable the reader to obtain a better idea of the circumstances of the case.

Ancient History of Bharatpore.

2. The present fort and city were founded by Suruj Mull in 1733 A.D. He first dug a moat and formed a mud fort in its centre. The moat "Nehir" is about 8,100 feet in length, 200 feet wide and 30 to 40 feet deep. The fort in the centre is roughly square on plan, and its ground is raised some 25 feet above the level of the surrounding town, which is itself at about the level of the surrounding country. It took Suruj Mull eight years to build this fort. He then proceeded to build a masonry wall round the fort and to erect two masonry bridges across the moat, this work was completed by 1756 A.D. His next step was to commence the city, he dug a ditch (khai) some 4 miles in circumference, using the earth in the city walls and bastions, ten gates were constructed as shewn on Map I. The fort lies within these walls towards the Eastern side of the city.

3. The site of the City was selected in what is practically a saucer, so that the fort moat and the city ditch (khai) could be easily filled with water for the sake of defence, the advantages of this site were reaped in 1805, when Ranjit Singh successfully held the city against the attacks of the British led by Lord Lake, and the Bharatpurians are still so proud of the mud walls which kept back the British that they will not consent to level them down to fill up insanitary hollows, fortunately from a sanitary point of view nature is gradually doing the work for them.

Existing drains within the town.

4. A number of Surface and Underground drains have been constructed from time to time for taking the drainage, *i. e.*, sewage into the fort moat or the city outer ditch (khai). Some of these underground drains are also used for taking water from the Atal and Moti Bunds outside the city into the Fort Moat, and through the city to the Gol Bagh Bund.

Unsanitary condition of the town.

5. The drains are built without any system, and lengths of them are aligned so as to slope inwards forming a cesspool. Thus for the last 150 years, since the City was founded, the whole of the sewage of the city comprising an area of about 1¼ square miles with a population of some 40,000 has been retained within the city walls excepting for a certain portion which falls into the outer moat. Some years ago, an attempt was made to take part of the drainage by a pucca drain at the Jageena Gate to the fields outside the city.

Within the last few years, conservancy carts have been supplied and an attempt made to remove some of the excreta and urine from the town, but the people continue to defecate in waste parts of the town. A Municipal Act is being drawn up,

provisions should be made for removing the whole of the excreta and urine out of the town, and to prevent the people from defecating promiscuously. It must naturally take some years under a strong regime to rectify the evils which have been the custom for a century and a half.

Surface Drainage a remedy.

6. The system of Surface Drainage proposed below will be of great assistance towards rectifying these evils.

Bad water supply.

7. The next evil to be mentioned is the contaminated supply of drinking water. The inhabitants draw their water (i) from the Fort Moat itself, (ii) from wells actually connected with the moat, (iii) from wells surrounding the moat at a distance of one to five chains, not actually connected, but relying in a great measure on the water in the moat for their supply through subsoil percolation, (iv) from wells outside the city whose supply may or may not to some extent be affected by the level of the water in the city ditch.

It should be mentioned that these wells are generally 50 to 80 feet deep, (See Appendix II), it is said that the subsoil water below R. L. of about 40 00 is brackish, how far this may be the case, I am unable to say, but that a systematic enquiry should be made into the question of the wells and subsoil water-supply in the city and neighbourhood suggests itself.

8. At present, as shown above, the inhabitants are drinking sewage. I have not gone into the question of health statistics, as it is beyond the scope of my enquiry, but I understand that the infantile death rate is excessively high, the ordinary death rate is excessive, the inhabitants generally have deteriorated in physique and are unhealthy and prone to disease, and last year when the plague broke out in the city, it caused tremendous havoc, a great number of abandoned huts can now be seen within the city, it would be interesting to know what the number of the present population amounts to, compared with the Census of 1901, which gave a return of 42,997.

Remedial measures.

The Town Moat should be purified and all drainage kept out of it.

9. Obviously the first thing to be done is to prevent any drainage from going into the Fort Moat, the moat must then be dewatered, cleaned out and refilled with clean water from the Atal and Moti Bunds, for choice the latter, and stringent measures taken to prevent any contamination of the water, dewatering the moat will, I am afraid, cause portions of the old moat walls to collapse, but this must be faced; the question of allowing bathing in the moat will be a difficult one to deal with, as long as the water in the moat is used for drinking purposes, no bathing should be allowed in it, this however, is a matter which may be left for future consideration.

Iron pipes should be laid through the city for supplying water to the Fort Moat from Atal or Moti Bunds; but if on account of expense or other reasons, it is not practicable to do this work at present, and the underground masonry drains have to be retained for feeding the Fort Moat, in that case the greatest care must be taken to exclude drainage from these conduits.

The city ditch should be filled up

10. As regards the city outer ditch (khai), it is gradually being filled up and cultivated, but on the Northern and Western sides of the town, many stagnant stinking pools still exist. I do not think these pools affect the water level in the adjoining wells, and recommend that they be filled up with earth brought from beyond the Circular Road, this would form a most useful relief work, it will not affect the present drainage of the city, as most of the outlets discharging into this ditch are either at a fairly high level, or closed up with debris, etc.

No previous scheme for removing drainage out of the town.

11. Two maps are appended to this report giving general levels of the city and district.

Excepting the small attempt mentioned in para 5 above, the question of removing to a distance the surface drainage of the town does not seem to have been seriously considered, it was taken for granted that as the city was more or less in a hollow pumping would have to be resorted to. A friend wrote to me as follows:—

"The only difficulty about draining Bharatpore is the want of an outlet, as the "ancients selected a hollow to build the town in, so that you could flood the double "moat at short notice against the besieging army. The moats were dug deep to "make the high walls of, hence all drainage goes into the moat. Until they have "a water-supply from outside, you cannot suggest filling up the moat, and digging "a deep outfall some miles long as the sweet water which flushes in every rains is "necessary to prevent the wells inside the city becoming two brackish to use. "Aesthetic consideration and old time associations apart, you would raze the "city walls refilling the moats with them, and then an outfall of moderate depth "could be dug and the sewage gravitated away.

"Until they get a regular water-supply (and the only at present apparently "really good supply that offers is from a magnificent reservoir at Bareta 27 miles away, "and the project will cost 12 lakhs), the only chance of removing the sewage is "by a big pumping scheme."

Proposed surface Drainage Scheme.

12. My proposal is to prevent the drainage from finding its way into the moats by making suitable catch water drains. The drainage from the Fort which is at a level of 138·00 to 110·00 will be collected and taken in pipes, covered or open drains over the two bridges across the Fort Moat to outlets in the city walls, the road levels of the bridges are 109·00 and 113·00 respectively, a catch water drain may be required around the Fort Moat, all the underground drains must be permanently filled up, after removing the sewage from them, subject to the remarks in Para 9 above.

The only drainage from the city that finds its way into the city ditch is by culverts made through the walls, these will all be closed up.

There are a few deep hollows in the city which should be gradually filled up. Otherwise the general level of the city varies from 96·00 to 111·00, less than one quarter being under 100·00.

The low portion of the city which is likely to give trouble to drain, is between the Kumher and Delhi Gate, and in the north corner of the city.

Outfall Drain to take the city drainage away into the country.

13. As before mentioned, the city is practically in a saucer, however, towards the east there is a gradual fall of the country in the direction of Agra.

The following channels are aligned in that direction:—

(*i*) The "Home "canal designed to take water from the Moti Tank north of the Railway into the Gol Bagh Bund, this channel is no longer used.

(*ii*) The Golal Kund drain designed to take (*a*) water from the Ajan Bund and also (*b*) from the Atal Bund by the underground drain passing through the city, to Gol Bagh, this drain is said to be used occasionally to take some of the surplus drainage out of the city; the fall given to this drain from near Muthra Gate to Gol Bagh is 1 in 1,000, an excellent fall, but it ends in the bed of the Gol Bagh Bund which is below Ground Level.

A possible line for an outfall drain is marked on map II, it is however for the local authorities to decide the actual alignment after making proper surveys, and considering all the circumstances of the case.

System of Bund Irrigation.

14. Before proceeding further, some mention should be made of the system of irrigation practised at Bharatpore, as this affects the question of an outfall drain.

Reference to map II shows that the whole area around the city is commanded by the following bunds, Ajan, Sewar, Atal, and Moti, these receive their supply of water partly from their own catchment area and partly from the rivers.

About September or October water is run from these bunds all over the wheat lands surrounding the town, and allowed to stand for a week or fortnight, after which it is drained off as much as possible.

Towards the East of the city the water from Ajan Bund is taken into the Noh Bund, 3rd Mile of Agra Road, and forced right up to Bharatpore city, flooding all the low lands around Gol Bagh.

The advisability of this wholesale flooding of lands around the city on Sanitary grounds is problematic. Major Stretton, formerly Political Agent, wrote :—

"The Climate of Bharatpore is decidedly unhealthy after the rains. The fort "and town were originally placed in low-lying land, to facilitate filling of the ditch "and moat around the fortification for purposes of defence, during the rains much water "collects about the city, or is held up in the Ajan and other Bunds, thus producing "malaria and its attendant ailments."

A Civil Surgeon in charge is said to have estimated that his bill for quinine exceeded the profits realised by the Irrigation around the city.

Personally I am opposed to rice cultivation being allowed near and within towns, but I do not think that a single irrigation for rubbee is as bainful, however I certainly think that the Noh Bund should be abolished, as it effectually seals the pool around the town by closing the single outfall for surface and subsoil drainage, further Gol Bagh is the site of an existing, and proposed New Palace for the Chief, and every effort should be made to keep that locality as healthy as possible.

Allowance of rainfall to be provided for in designing the drains.

15. The practice in Bengal is to design the drains to carry off ½ inch of rainfall an hour from urban areas and ⅓ an inch an hour from rural areas, for towns east of Burdwan, where the rainfall exceeds an average of 45 inches to 50 inches per annum; and half that amount for towns west of Burdwan. (Page 19 of Mr. Silk's Manual.)

The average annual rainfall of Bharatpore is 25 inches, but as much as 5 inches may fall in one day.

The area of the city excluding half the walls and the moat is about 635 acres, of which two-thirds may be taken to be urban and one-third rural. It will probably suffice to make an average allowance of ·15 inches per hour over the area of 635 acres, *i. e.*, the final outfall drain must be able to carry 96 cusecs.

Scheme for Surface Drains within the City.

16. The drains should be designed on the lines of Mr. Silk's Manual of Surface Drainage. I am strongly in favour of using glazed drain tiles set in concrete for the bottom of the drains when the cost is not too heavy, the upper portion of the drain can be of brick masonry or concrete with portland cement plaster lining.

An inspection of map I, which gives the general levels of the city, shows that there will be no difficulty in designing surface drains to take all the drainage from the fort across the two moat bridges.

For the rest of the city, a line joining Neemdah Gate to Luxmanjee's Temple may be taken as the apex, and drains designed going round the town in both directions, as far as the main street running from the Muthra Gate to Kumher Gate, these drains will probably be subsidiary drains of comparative small sections, from that street these drains will gradually merge into main drains, other subsidiary drains will collect the drainage from the Fort and the remainder of the city, themselves merging into other main drains ; the main drains will be taken to the outlet culverts to be constructed through the city walls.

For the low grounds towards the north of the city, lying below a level of 99·00 or 98·00, a lower level drain will be required which will discharge into the main outfall drain, through a sluice with a flap shutter, this low level drain will not be able to discharge excepting when the outfall drain is running half full or less ; this is probably a better expedient than giving this low level drain an outfall drain of its own to discharge into a small sewage farm in the low ground near the Railway culvert, Map I.

ading of the s within the

17. The drains which must all be masonry, must be designed so as to make full use of whatever fall is available in order to obtain a sufficient velocity in the drains to render them self-cleansing as far as possible.

There is however on the other hand the imperative necessity of obtaining as high a water level as possible at the outlet culverts in the city walls, so that whilst satisfactorily draining the city, there may be as much head as possible for the outfall drain outside the city as the fall of the country is very little.

In designing the drains, remember to work from the full supply water level and not from the beds, generally whenever there is an increase of section, taking Mr. Silk's sections, there will be a drop in the bed, but not in the water level, sometimes this point has been overlooked and the beds of increasing sections kept at the same level, so that the water would have to run uphill to fill the drain.

Appendix III gives a useful form for tabulating the details of the drains.

tlet Culverts ugh the city s.

18. Until the detail surveys of the city are made, and the scheme elaborated, it is impossible to say definitely how many outlet culverts through the city walls are desirable, whether there should be (i) *one* main outlet near the Jageena Gate, or (ii) at some point between the Jageena and Muthra Gates, or (iii) *two* outlets, one near the Jageena Gate and another somewhere between the Muthra and Soorujpol Gate, or (iv) *three* outlets, two as in (iii) and a third somewhere near the Gourdhun Gate.

At this stage of the enquiry I am not able to fix definitely the levels for the outlet culverts through the city walls, but every attempt should be made to obtain a water level at the Jageena Gate if not lower than 97·00, and as much higher as possible—for the low level drain mentioned in para 16 above, the water level may have to be as low as 95·00.

tfall drain.

19. The alignment of the main out-fall drain needs careful consideration.

The following are some of the points to be considered:—

I. Shall the drain be for the city drainage only and quite indepen. of any drains necessary, (a) for discharging rain-water from outside the city, (b) for taking water from Bunds for the supply of Gol Bagh Bund, or Diggis, which I take it, are earthen tanks generally near a well for the purpose of increasing its water-supply.

II. Shall the present alignment of either the Golal Kund drain or "Home" Canal or both be followed, or

III. Shall a new line along the Agra Road or in its vicinity be adopted.

I should like if it is possible to take all the drainage of the city from the Jageena gate to some point on the "Home" Canal and thence along this canal properly graded to its end, K. Map II, thence avoiding Gol Bagh as much as possible to a terminal point either near 3 mile or 4½ mile of Agra Road, but this is a question which must be decided by the local officers when the surveys have been completed.

The drain might be utilized for discharging rain-water outside the city which would help to flush it, but it should not be used for taking Bund-water to Gol Bagh Bund, as the water for that Bund should be as pure as possible. See paragraph 14 above.

I understand that the "Home" Canal is no longer used for taking water from the Moti Jheel, and that it can be utilized for the town drainage. It may be argued that it is not desirable to take the drainage through the Victoria Park, but it would pass at some distance from the part of the Park which will be most frequented and need not be any nuisance if kept flushed.

If it is found necessary to adopt the alignment of the Golal Kund Drain for part of the drainage, it should be covered over in the vicinity of the medical officers'

house, and a separate water-course be provided for taking Bund-water to Gol Bagh if water is required there.

Grading and Section of the outfall drain.

20. Assuming a water level of 97·00 at Jageena Gate a fall of about 1 in 3000 can be obtained, it will be necessary to provide a small masonry drain to carry the hot weather discharge as far as 15,000 chain. I have drawn a proposed section for the drain on Map II. The masonry drain will carry 4 to 5 cusecs: and the earthen drain with 4 feet depth of water measured from the bottom of the masonry drain will carry 96 cusecs. The levels will be approximately as follows:—

	Ground Level.	Bed of Masonry drain.	Water Level
Jageena Gate	... 102·00	93·00	97·00
5,000 feet	... 98·00	91·30	95·30
10,000 feet	... 94·00	89·60	93·60
15,000 feet	... 90·00	88·00	92·00

I am not sure of the correctness of these ground levels, but they are not very far wrong.

Sewage farm.

21. It may be advisable to make a small sewage farm at 15,000 chain where the masonry drain ends, for the hot weather discharges, in order to prevent there being a nuisance near Gol Bagh; as mentioned in Mr. Silk's Manual, there is always a nuisance at the end of a masonry drain in the Hot Weather, the filtration through cinders suggested in Mr. Silk's book has proved to be unworkable. Possibly it would be better to continue the masonry drain to a point beyond Nol Bund, and make the Hot Weather Sewage farm there. The slope of the outfall drain is of necessity exceedingly flat, so special arrangements for providing a heavy flush for it must be made.

Flushing.

22. A most important consideration is—Whence can the water for flushing the drains be obtained.

Sullage water and urine must of necessity be allowed into the surface drains and some fæces will also find its way into the drains, until the conservancy arrangements are completed for providing latrines and a sufficient number of conservancy carts and sweepers to remove all the fæces out of the city, a work which must take many years, however energetic the Municipal officers may be; since sewage will be taken into the drains, provision for flushing the drains twice a day must be made.

I had not time to go into the question of the capabilities of existing wells. Enquiry may show that some of the existing wells are suitably situated, and can give a sufficient supply of water for flushing part of the drains; but it will probably be necessary to sink 3 or 4 extra wells, which may be about 100 feet deep to penetrate into the subsoil reservoir, which is said to contain plenty of brackish water which will do for flushing.

23. Another alternative would be to take water from the Fort Moat. The average superficial area of the Moat is 8,100 feet by 200 feet=16,20,000 sq. ft., it is advisable if possible, to keep the water level in the Moat at 20 to 30 feet on the gauge. The amount of water at present used during 12 months is approximately 10 feet depth representing 162,00,000 c. ft. or about 100 million gallons; of this, half is lost by evaporation and percolation, and the rest is used for drinking and household purposes and for watering the parks.

24. The question now to be answered is, what amount of water is required for flushing, there is unfortunately very little information available on this point. Silk's Manual says 250 gallons is required to flush a main drain, but he does not mention the length or size of the drain—two important factors in main drain flushing. The system of flushing to be adopted should be to flush the subsidiary drains leading into a main drain at one and the same time, as far as possible, so that their combined waves may meet in the main drain and clean it out.

Figures obtained at Patna tend to show that on an average about ½ gallon per running foot of drain to be flushed is required. Assuming that there will be about 10 miles of drains to be flushed in Bharatpore city, the amount of water required is 26,400 gallons for one flushing. Two flushing should be given daily, therefore 52,800 gallons are required or 193,23,000 in the year, which represents 2 feet depth of the moat; in years of good rainfall, when the moat tank can be filled up at the end of October to 30 feet on the gauge, the water for flushing could be spared, but in years like the present one when the rains have failed, and there is no water available for filling up the moat, it could not be spared; the moat gauge read about 18·00 during October 1905, so it would be better if special wells were provided for flushing purposes.

These wells, which can be outside the city, must be connected and a pump and engine used to raise the water for flushing.

Pipes will be laid down over the town and water pumped into them under pressure, the roads can also be watered from these pipes, when sufficient water is available.

25. There are practically no urban suburbs of the city, there are a certain number of shops and houses outside the Muthra Gate, for which masonry drains could be made which may discharge into the city drains, or into adjacent cultivated land, if the second alternative is adopted, sewage should be kept out of these drains. The rural Suburbs, including the Civil Station, will not require masonry drains.

26. An estimate for the cost of the drainage system can at the best be only approximate. I am basing it on the cost of similar works carried out in Bengal, but am making no allowance for land or for compensation for houses, trees, etc., that may have to be removed, nor for dewatering and cleaning out the Moat Fort, which is hardly a legitimate charge against a drainage scheme. I do not think the cost for land in the city should be much, as many of the drains will be along the roads, and there is a great deal of waste land in the town, and where houses do exist, the larger proportion of them are only mud huts; for the outfall drain also, the cost of land should not be excessive.

Estimate—For 600 acres subsidiary and main drains at Rs. 200 an acre	Rs.	1,20,000
Outfall, 5 miles at Rs. 1,000	„	5,000
Outfall Masonry central drain, 15,000 feet, at Rs. 3 ...	„	45,000
Closing old drains	„	2,500
Flushing	„	60,000
Survey	„	2,000
	Rs.	2,50,000
Establishment, T. & P. and contingencies ...	Rs.	50,000
Total ...	Rs.	3,00,000

The provision for flushing of Rs. 60,000 needs some explanation. It is based on actual figures obtained from the Patna Installation, allowing a margin. The Engine and Boiler which should be in duplicate should be capable of lifting 10,000 gallons an hour against a head of 150 feet. Pipes varying in diameter from 6" to 3" should be laid to the summits of all subsidiary drains, a 2" cock to be given at the head of each subsidiary drain and hydrants for watering roads could be fixed at every 150 feet, pressure required in the pipes will be about 20 lbs. for flushing and 30lbs. for road watering.

Estimate—Say pipes	3,000	feet of	6	inches	diameter.
	5,000	„ of	5	„	„
	5,000	„ of	4	„	„
	11,000	„ of	3	„	„
Total	24,000				

Weight of pipes about 200 tons at Rs. 150	Rs.	30,000
2 Engines with boilers and pumps	„	10,000
Taps, Cocks, Valves and Hydrants	„	4,000
Buildings	„	1,000
4 wells connected by 6 inch pipes, each well 10 feet diameter and perhaps 100 feet deep, as found necessary	„	15,000
Total ...	Rs.	60,000

The annual maintenance for flushing will be about Rs. 3,000.

I have purposely made the estimate rather in excess of what I think will b actually necessary, as being a fault on the right side. As mentioned by Mr. Sil in his Manual, page 16, the work can be done piecemeal as funds avail,

Survey and preparation of the project.

27. The first thing to be done is to prepare complete surveys and levels of th areas to be drained and the proposed outfalls; pages 4-8 of Mr. Silk's Manu Some 50 Bench Marks cut on stone or in portland cement plaster should be c structed.

The next point to decide is (paragraph 18) the levels for the outl from the city and the number of outlets required, after which the drains can designed making the best use of the fall available, and then the outfa drain; after which the estimate can be framed, approved, sanctioned and th work put in hand.

28. For easy reference the following note of paragraphs specially referrin to the proposed scheme is given :—

Para 9. Remedial Measures. The Town Moat should be purified, and a drainage kept out of it.
„ 10. „ „ The City Ditch (khai) should be filled up.
„ 12. Proposed Surface Drainage Scheme.
„ 13. Outfall Drain.
„ 15. Allowance of rainfall to be provided for in designing drains.
„ 16. Scheme for Surface Drains within the City.
„ 17. Grading of „ „ „ „ „
„ 18. Outlet Culverts through the City Walls.
„ 19. OutfallDrain.
„ 20. „ „ Grading and Section:
„ 21. Sewage farm.
„ 22-24. Flushing.
„ 25. Suburbs.
„ 26. Estimate.
„ 27. Survey and preparation of the project.

I shall be very pleased to give any further information that may be requi and to criticise the project when it is prepared.

The 21st October 1905. C. A. WHITE, M.I.C

Appendix I.

Rainfall at Bharatpur (P. W. D. Office).

Name of month.	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
nuary	...	...	...	...	0·15	1·22	0·01	·05	...	·75
ruary	...	...	3·57	...	...	1·16	...	...	...	1·04
ch	...	...	...	...	...	...	...	0·42	...	1·27
l	...	...	...	...	0·50	...	...	...	...	·04
... ...	...	...	1·06	1·42	1·10	0·71	0·36	...	1·20	·02
... ...	0·92	1·80	3·70	11·31	0·01	0·75	1·73	1·38	1·74	·47
... ...	9·85	12·78	2·25	10·34	0·20	6·23	19·36	4·29	10·38	5·76
ist	1·59	11·30	8·10	0·18	5·01	3·85	4·37	8·54	17·62	1·11
mber	...	3·08	1·38	1·11	0·60	0·19	4·72	4·87	2·22	2·38
oer	...	...	...	...	...	2·41	...	4·45	...	...
mber	...	...	...	...	...	...	...	...	0·50	...
nber	...	...	0·19	...	1·11	0·80	...	...	1·21	...
Total ...	12·36	29·46	20·25	33·36	27·37	17·32	30·55	23·90	34·87	12·04 to 25 Oct.

Average for nine years 25·55.

Heavy falls in 24 hours :—

15·7·96 ... 4·63

2·8·98 ... 3·30

26·6·99 ... 3·25

30·7·02 ... 2·06

31·7·02 ... 3·78

25·7·04 ... 4·35

12·8·04 ... 5·05

Appendix II.

Wells near the Fort Moat, the October 1905.

No.	Name of Well.	Locality.	Name of Owners.	Surface of Water.	Bottom of Well.	Ground Level.	Remarks.
1	Khirni Walá ...	Near Zanana Ghat ...	Perohatji	81	62	101	Reduced Level
2	Gola Kawar ...	„ Temple Bharatpore...	State	83	62	100	
3	Masjid Walá ...	„ Kotho Nazim Sahib ...	„	84	58	102	
4	Hath Walá ...	„ Gordhan Gate ...	„	82	50	97	
5	Gola ...	„ Artillery Shed ...	„	83	42	97	
6	Phulbari Walá Gola ...	„ Revetment Wall ...	„	82	33	97	
7	Maszid Walá ...	In Mistri Khana ...	„	81	71	102	
8	Big Well in Gopalgat ...	Near Haweli of Bakshiji...	„	83·50	45	.....	
9	Choburja Walá ...	Godown in Board ...	„	89	56	105	
10	Kothar Walá ...	In Fort	In Fort.	84	54	120	
11	Nahar Singh Walá ...	Near Gharohara's line		94	42	120	
12	Devi Singh Walá ...	Kothi Fojdar Debi Singh		85	77	120	
13	Mandar Walá ...	In Temple of Lala Maharaj in Fort		90·50	77	140	
14	Behareji Walá ...	„ Beharji		86	72·50	138	
15	Ganga Mandir ...	„ Gangajees Temple		84	50	107	

Zero of Moat Gauge ... 88·41.

Fort Moat Water Level October 1905 ... 85·00.

Appendix III.

Statement showing the particulars of $\frac{MAIN}{SUBSIDIARY}$ *Drain of BLOCK No._____ with areas and discharges estimated at_____ inch of rainfall per hour.*

No.	Names of Roads and Lane.	Reference on plan by chainage.	Reference on plan by letters.	Cardinal direction.	Area to be drained in square feet.	Length of drain in feet	Inclination 1 in feet.	Size of drain.*	Full discharge of drain in cubic feet per second.	Required discharge in cubic feet per second.	Maximum velocity.	Remarks.

* See Silk's Manual.